

BRIEFER ARTICLES.

DEFINITENESS OF VARIATION, AND ITS SIGNIFICANCE IN TAXONOMY.¹

IN descriptive and systematic botany we have just two things with which to deal, types and variants. The types are the comparatively absolute standards by which we measure the variations; but the variants occupy most of our attention. The type is the one fixed point for each species, while the limitations which we fix for the species represent the extent of possible (permissible) variation from the type as determined by our arbitrary species measure. The ideal way to study systematic botany would be to keep the types always before us, and to describe each specimen by computing its variation from this or that type. This is, in fact, what critical study amounts to. In other words, the systematist is always measuring and classifying variations. If, therefore, definite lines of variation can be traced, it ought to be a matter of great convenience.

The two opposing schools of evolutionary philosophers are divided at present as to whether variations actually do occur in definite directions or not. But even Weismann² wrote in 1875, perhaps before he was so strongly confirmed in his present position, "the evolution of the species of *Deilephila* shows that the evolution of the marking follows throughout a certain law; that it proceeds in all species in the same manner. All species seem to steer towards the same point, and this gives the impression that there is an internal law of evolution which, like an impelling force, determines the future phyletic modification of the species."

The Neo-Lamarckians are very positive on this point. Eimer³ says "I have, from the zoological standpoint, pointed out and emphatically maintained that the variation of species takes place, not in all directions irregularly, but always in definite directions; and indeed in

¹ Condensed from address before the Vermont Botanical Club, February 6, 1897.

² Quoted by Eimer, *Organic Evolution*, Eng. Ed., 73.

³ Dr. G. H. Theodor Eimer, *Organic Evolution*.

any given species at a given time in only a few directions." Nägeli also asserts that "the transformation of varieties, species, genera, and families, is effected in definite directions, toward greater perfection, that is, toward greater complexity. Forms grow as it were toward greater perfection. This principle is of a mechanical nature, and constitutes the law of the persistence of motion in the field of organic evolution. Once the motion of evolution is started it cannot cease, but must persist in its original direction." Cope⁴ takes advanced ground on this question. He says "variations are not promiscuous or multifarious, but are of certain definite kinds, or in certain directions."

So much for the philosophers. What are the facts? Every botanical variety represents with greater or less accuracy some definite line of variation from a specific type. Thus *Ambrosia trifida* L., of which the type has large, deeply three-lobed leaves, tends constantly to vary toward ovate or oval, undivided leaves, especially in the upper parts and in small plants. The most conspicuous of these variants constitute the variety *integrifolia* of Torrey and Gray. *Aster diffusus* Ait. is described as "more or less pubescent;" but those which are much "more pubescent" make up Gray's variety, *hirsuticaulis*. The common ox eye daisy, *Chrysanthemum Leucanthemum*, is notably variable, but the variations are principally in a few quite definite directions, the commonest being toward tubular or laciniate rays.

In horticultural botany we have still better opportunities of observing similar facts. A very striking case of variation in definite directions was worked out during the fall of 1896 by one of my students, Mr. V. A. Clark, in the case of *Coreopsis tinctoria* Nutt. This western composite has been widely introduced in gardens. French and German seedsmen offer many selected named varieties, most of which are sold in mixture by American dealers. These varieties, being well represented on our grounds, were suggested to Mr. Clark for study and classification. It could hardly have been an accident that the varieties, after careful study and quite without knowledge of any theory of variation, should have all fallen into one series. In this species the rays are yellow with a very small but variable maroon base. In the varieties this maroon marking constantly encroaches upon the yellow, until in extreme forms it quite supersedes the body color. One is given the impression that the maroon overlays the yellow in this extension; and this is progressively indicated by the very

⁴E. D. Cope, Primary Factors of Organic Evolution 22.

definite course of evolution in the marking of the under side of the ray also. For on the under side the brown appears first in the thinner portions of the ray, and last on the thick veins. It is as though the brownish pigments were spread first over the upper surface and subsequently increased in depth, first showing through in the thin areas.

Precisely the same series was later constructed from blossoms of the commercial *Freesia refracta alba* grown in our greenhouses. In this case we have a reversion from the highly selected white type. But the appearance of an orange yellow spot at the base of the upper petal and its extension over first the inner surface, and secondly its appearance on the backs of the petals, followed the same definite lines as those already studied in *Coreopsis tinctoria*. In this case sections were made through petals from various blossoms in the series. In the first appearance of yellow pigment it was confined to a single layer of sub-epidermal cells, and was from here subsequently propagated through the intermediate cells to the under surface of the petals.

This centrifugal encroachment of a darker upon a lighter color in blossoms is one of the commonest lines of definite variation. In *Lepachys columnaris* Torr. and Gray it gives the variety *pulcherrima* Torr. and Gray. In the florists' *Primula Chinensis* it gives the beautiful "Schwarzaugen" varieties of late German catalogues. With more or fewer exceptions the same method governs the variations in markings of marigolds, verbenas, phloxes, poppies, pelargoniums, irises, and dozens of other species and genera which will readily occur to the gardener.

It is quite remarkable that any given lot of variations should happen to fall into one continuous series; and this becomes of still greater importance when found to hold true with groups of highly cultivated and severely selected plants, like the *Coreopsis* and *Freesia* cited. It is no longer final to say that variations "are as definite as the changes in environment are, which determine and control their existence,"⁵ for the gardener seeks variations in all directions, and inasmuch as he controls both environment and selection, he will preserve and augment whatever variations nature may give him. If, in such cases, variations are to be systematized with comparative ease, a careful study along similar lines ought to give some clue to a better understanding of troublesome variations in many of our unstable wild species.—F. A. WAUGH, *University of Vermont*.

⁵L. H. Bailey, *Survival of the Unlike* 23.